

LIGHT CHARGED-PARTICLE PRODUCTION ACTIVATION CROSS SECTIONS OF ZR ISOTOPES FROM 14 TO 20 MeV

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Neutron-induced reaction cross sections for structural materials are basic data for evaluation of the processes in these materials under irradiation in reactors. Neutron-induced reactions on zirconium are of particular importance in a wide range of applications [1]. In addition to its use in current reactors Zr is present in most innovative concepts. Of particular importance to structural materials are the hydrogen and helium production cross sections that impact material damage and handling limits. Radiation hazards and decay heat are associated with the activation products. Studies of excitation functions of fast neutron-induced reactions are important for testing nuclear models. In the investigated energy region many reaction channels are open (e.g., elastic and inelastic scattering, radioactive capture, (n,2n), (n,p), (n, α), (n,np), (n,nd), (n,n α) etc.). To account for the reaction channels that are open the direct, preequilibrium and statistical processes should be considered.

New results were obtained for the $^{90}\text{Zr}(n,\alpha)^{87m}\text{Sr}$, $^{90}\text{Zr}(n,p)^{90m}\text{Y}$, $^{90}\text{Zr}(n,2n)^{89m}\text{Zr}$, $^{91}\text{Zr}(n,x)^{90m}\text{Y}$, $^{91}\text{Zr}(n,p)^{91m}\text{Y}$, $^{92}\text{Zr}(n,x)^{91m}\text{Y}$, $^{92}\text{Zr}(n,p)^{92}\text{Y}$, and $^{94}\text{Zr}(n,p)^{94}\text{Y}$ activation reaction cross sections in the energy range from 14 to 21 MeV. The irradiations were carried out at the 7MV Van de Graaff accelerator at IRMM, Geel. Quasi-mono-energetic neutrons with energies between 14.8 and 20.6 MeV were produced via $^3\text{H}(d,n)^4\text{He}$ reaction at 1, 2, 3, and 4 MeV incident deuteron energy. Both natural and samples enriched in ^{90}Zr , ^{91}Zr and ^{92}Zr were used. All reaction cross sections measured in the present work are referenced to $^{27}\text{Al}(n,\alpha)^{24}\text{Na}$ standard reaction cross section. Neutron flux spectra were determined using neutron-spectrum information obtained by time-of-flight method and spectral index method that involves various monitor reactions with distinct energy thresholds. Standard gamma-ray spectrometry was employed for measurement of radioactivity. Corrections have been applied for sample irradiation and counting geometry, beam intensity variation during irradiation, background neutrons, neutron absorption and scattering, gamma-ray absorption and gamma-ray sum coincidences, and correction for interfering reactions leading to the same product. For more details about the method see Ref. 2 and Ref. 3.

The measurement results are compared with work by other authors, current evaluated data files and new model calculations.

1) The NEA High Priority Nuclear Data Request List, NEA Nuclear Science Committee, 2002, available at <http://www.nea.fr/html/science/docs/pubs/hprl.pdf>.

2) A. Fessler et al., Nucl. Sci. Eng. 134, 171 (2000)

3) P. Reimer et al., Phys. Rev. C65, 014604 (2001)